SERGENT, HAUSKINS & BECKWITH

PHASE II

SLURRY CUTOFF WALL
PLANS & SPECIFICATIONS

FOR:
DRY FORK IMPOUNDMENT
UTAH COPPER DIVISION
BINGHAM CANYON MINE
SALT LAKE COUNTY, UTAH

SHB Job No. E84-2024

Consulting Geotechnical Engineers
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APPLIED SOIL MECHANICS • ENGINEERING GEOLOGY • MATERIALS ENGINEERING • HYDROLOGY

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September 21, 1984

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SHB Job No. E84-2024

Attention: Mr. Ward Wimborne
Manager of Engineering

Re: Dry Fork Impoundment Study
Slurry Cutoff Wall Plans &
Specifications
Bingham Canyon Mine
Salt Lake County, Utah

Gentlemen:

Transmitted herewith are preliminary plans and specifications for construction of the slurry cutoff wall proposed for the Dry Fork Impoundment.

Details of the plans and specifications may change, dependent on the results of the exploratory drilling and seismic work that is presently being done. In particular, after a review of the bedrock profile determined as part of the field investigation, the plan location of the slurry cutoff may be changed from that shown to take advantage of a shallower depth to bedrock.

Details of the placement of the liner at its connection to the slurry cutoff are not presented on the drawings included

herein. This and other liner details are included in the plans and specifications for the liner.

Details of the plans may also change dependent on the surveying that is presently being done. Once cross sections or a more detailed topographic map of the general slurry cutoff location are available, a more detailed representation of the project layout, including construction bench, can be completed.

Should any questions arise concerning this project, please do not hesitate to contact us.

Respectfully submitted,
Sergent, Hauskins & Beckwith Engineers

By _____
Paul Kaplan, Staff Engineer

Reviewed by _____
Lawrence A. Hansen, Ph.D., P.E.

Copies: Addressee (3)

TECHNICAL SPECIFICATIONS
SLURRY CUTOFF WALL CONSTRUCTION

1. Scope

This specification includes requirements for construction of a soil-bentonite (S-B) slurry cutoff wall, as indicated on the project drawings, as specified herein, or as required to properly complete the work.

2. General

An impervious cutoff wall shall be constructed by means of the slurry trench method, or by means of slurry filled large diameter borings. The wall shall be constructed to the lines, grades and cross sections as indicated on the drawings. The trench shall have a minimum width of 3.0 feet and shall extend down through the subsurface materials to the elevation indicated herein.

The lines, grades and elevations shown on the drawings are approximate and should not be considered as finished grade elevations. Boring and test trench logs presented in the geotechnical report are for information only, and represent subsurface conditions only at the specific locations. Depths to bedrock and subsurface conditions may vary between borings shown on the profile cross section for the cutoff wall location.

The installation of the cutoff wall shall be carried out by, or under the supervision of, a contractor qualified to do slurry-assisted construction. A qualified contractor should have at least three years experience in slurry-assisted construction, including either slurry trench or large diameter drilled pier construction. A qualified contractor shall have completed at least two projects of similar scope and magnitude.

3. Site Preparation

The cutoff trench site shall be leveled and cleared of

vegetation and other deleterious materials which may contaminate backfill materials. The cleared area shall include the plan footprint of the construction bench.

The cutoff trench shall be excavated from a construction bench composed of compacted clayey mine waste rock. Construction of the pad will be the responsibility of others and is not included in this specification.

Proper means of mixing and storing bentonite slurry shall be provided. Dikes or other means to prevent unintentional flow of backfill into the excavated cutoff trench shall be provided, if backfill mixing is accomplished close to the cutoff trench.

Any pipelines or conduits found intersecting the cutoff shall be precisely located and removed in the presence of the representative of the geotechnical engineer.

4. Trench Excavation & Maintenance

4.1 Excavation Dimensions

The slurry trench shall be excavated with a minimum width of 3.0 feet. The trench shall extend a minimum of 1.0 foot into bedrock. The exact depth of the excavation shall be determined by the representative of the geotechnical engineer on the basis of field observations.

If an excavating bucket is used, its width shall be at least the specified width of the cutoff wall. If the cutoff trench is to be excavated by large diameter borings, an excavation plan, including location and sequence of placement of holes, shall be submitted to the geotechnical engineer for review a minimum of two weeks prior to beginning the excavation. If borings are used, overlapping of adjacent borings will be required, forming a secant wall. One or two rows of borings can be employed, but in either case the specified width, as measured from intersection points of the borings, shall be met.

If excavation is to be accomplished by clamshell, bucket or similar equipment, the excavation shall be carried to final depth at the point where excavation is started, and the entire depth of cut shall then be carried along

the trench line. If large diameter borings are used, each boring shall extend to the full depth of the cut at that point. Special equipment may be required to penetrate the required distance into bedrock.

4.2 Slurry Placement & Maintenance

Slurry shall be introduced into the trench or borings when excavation begins. The slurry level in the trench or borings shall be maintained within 1.0 foot of the working surface at all times. At no time shall the slurry level be less than 3.0 feet above the groundwater level. Slurry shall meet the specifications in Section 5.

Just prior to backfilling the trench bottom, the area to be backfilled must be cleared of loose material. Such material includes sand and sediment from the slurry or the trench, or other deleterious material. Procedures used to clean the trench bottom should not damage the trench sides. To ensure trench continuity, excavating tools shall be passed horizontally and vertically in the trench for its full depth. If large diameter borings are used, the bottom of the hole shall be cleaned of any slough, sand and sediment from the slurry, or other deleterious material.

The contractor shall maintain the stability of the excavated trench, or of the large diameter borings, at all times for the full depth. Damage to the filter cake on the sides of the trench during excavation shall be minimized.

4.3 Excavation Sequence

It is assumed that trench excavation will proceed in a continuous operation. Should trench excavation proceed in sections, with backfilling also being done in non-continuous sections, overexcavation must extend into previously placed backfill material in a method approved by the geotechnical engineer. Approximately 10.0 feet of overexcavation along the previously placed backfill should be anticipated.

Excavation by large diameter borings will necessarily be discontinuous, and overexcavation of previously backfilled borings will be required. The extent of

overexcavation will be dependent on the diameter of the boring, and should be clearly indicated on the excavation plan provided to the geotechnical engineer.

5. Slurry

5.1 Design Mix

A bentonite slurry shall be used in the construction of the cutoff. This slurry will be utilized for both holding the slurry trench or boring walls up and for mixing with stockpiled soil material to make the cutoff trench backfill. Only slurry meeting the criteria presented herein shall be introduced into the cutoff trench.

The slurry shall be composed of a uniform and stable suspension of commercial grade bentonite (A.P.I. Specification 13A) and water mix with a density of not less than 65 pcf (1.04 g/cc.). This mix shall not contain bentonite lumps. Bentonite shall be an approved Wyoming bentonite, and water should come from an approved local source. Minimum viscosity of the slurry shall be 40 seconds, as tested by a Marsh funnel. Typically, this will require from 5 to 7 percent premium grade bentonite by weight.

Slurry in the trench or boring bottom shall have a density of at least 15 pounds per cubic foot lighter than the backfill. This will assure proper slurry displacement. The slurry shall not be thickened to the point that it will not pass through the Marsh funnel. This is critical in the slurry near the leading edge of the backfill in trench construction.

5.2 Slurry Mixing

Slurry shall be mechanically mixed to assure that it is uniform and without bentonite lumps. Dry bentonite shall not be added to slurry in the trench, but shall be added in the slurry preparation area. To assure that slurry prior to use meets the criteria presented above, that slurry shall be pumped or otherwise mechanically agitated to achieve uniformity immediately prior to use. Sufficient time to hydrate bentonite shall be provided prior to backfilling or testing.

5.3 Slurry Reuse

As slurry is used in the cutoff trench or borings, it may pick up sands and fines which could increase its density. If this slurry is to be reused, sands shall be removed by an approved method. Care must be taken to assure that an increase in slurry wet density does not exceed the minimum wet density differential of 15 pcf between slurry and backfill.

6. Slurry Backfill Material

6.1 General

The cutoff trench or borings shall be backfilled with an engineered backfill mix consisting of slurry and an approved clayey sand which is neither uniform nor gap graded. Mixing will be done in a manner which thoroughly blends the backfill materials. Backfilling the trench or borings must be accomplished in a manner which does not result in backfill falling through slurry with a resulting separation of materials.

6.2 Backfill Borrow Quality Requirements

The backfill prior to mixing with the slurry wall shall conform to the following gradation limits:

Sieve Size	Percent Passing by Weight
3 inch	100
3/4 inch	90-100
no. 4	70-100
no. 40	35-65
no. 200	20-50

The material shall be free of vegetation, organic matter, debris and other deleterious material, and shall have a plasticity index greater than 5 and less than 35. Backfill shall be obtained from borrow areas designated on the drawings, unless other suitable material is located and approved for use by the geotechnical engineer. Backfill obtained from designated borrow areas may require processing.

6.3 Slurry Backfill Design Mix

The design mix should have a slump of between 2 and 6 inches for proper placement. An adequate amount of slurry shall be added to the soil component to have a minimum dry weight bentonite content of 1 percent. If more water is needed to reach acceptable slump, it should be added. If the amount of slurry necessary for a minimum 1 percent bentonite content results in too much slump, dry bentonite may be added to the mix to achieve acceptable slump and bentonite content.

Slurry from the trench or borings is suitable for addition to the backfill mix. Admixtures of the types used in the control of oil field drilling muds may be used only as approved by the geotechnical engineer.

6.4 Mixing Procedures

Mixing shall be done in an acceptable manner which results in a well blended material. Slurry shall be added to backfill soil and blended. If additional water or bentonite is needed, they will be added and blended. Additional bentonite shall be added in a manner that prevents it from balling up or clumping, and must be evenly distributed through the backfill mix.

Mixing shall be done in a manner that prevents any of the backfill mix from flowing into the cutoff trench or borings. Should any of the backfill mix flow into the slurry trench or borings, it must be removed. This shall be done by cleaning the bottom of the trench or boring after that material has settled.

6.5 Backfill Placement

Backfill must never be allowed to free fall through the slurry. Backfilling the cutoff trench shall be done by slowly pushing backfill into the trench at one end and letting progressive slope failures in the backfill within the trench displace slurry. As the trench is backfilled, the backfill mix is introduced at the edge of the backfill at the surface. To begin the backfilling operation, backfill mix shall be placed on the bottom end of the trench by clamshell until adequate backfill is in place to permit "slope failure" backfilling from the surface. Trapped pockets of slurry must not be

present within the backfill mass. Prior to backfilling, the cutoff trench bottom shall be cleaned as described in Section 4.2. It is recommended that the advancing backfill be kept as close as possible to the point of excavation.

Backfilling borings shall be by methods approved by the geotechnical engineer that will ensure free fall is prevented, and that the slurry is fully displaced ahead of the backfill in an upward direction. The contractor shall submit to the geotechnical engineer a detailed backfilling plan for large diameter boreholes for review a minimum of two weeks prior to beginning excavation.

7. Cutoff Wall Cap

7.1 General

The cutoff wall will be capped with a random fill embankment at such time that the trench backfill has settled to a stable configuration and the wall has been brought up to finished grade. The embankment cap will be constructed to the lines and grades shown on the drawings. The slurry wall cap borrow will be excavated from areas designated on the drawings, unless other suitable material is located and approved for use by the geotechnical engineer.

7.2 Quality Requirements

The materials shall be silty and clayey sands which meet the following gradational requirements:

Sieve Size (Square Openings)	Percent Passing by Weight
3 inch	100
1/4 inch	85-100
no. 4	70-100
no. 10	60-100
no. 16	50-95
no. 40	35-80
no. 100	25-60
no. 200	20-50

The material shall have a plasticity index in the range of 5 to 35.

Because of selective deposition within the designated borrow area, coarser grained soils may be encountered. Selective mixing of these soils with the finer grained soils will eliminate the potential for coarse sand zones extending continuously through the embankment zone. The material shall be free of vegetation, organic matter, debris and other deleterious material.

7.3 Placement & Compaction

Embankment materials shall be placed in maximum compacted lift thicknesses of 8 inches in continuous and approximately horizontal layers. The placed material can be compacted by a grid-type roller or other compaction equipment approved by the geotechnical engineer. A relatively rough surface shall be achieved so a firm bond is developed between each lift. Embankment materials will be compacted to a minimum of 95 percent of maximum dry density, as determined in accordance with ASTM D698. The moisture content during compaction will be maintained between 2 percent below and 3 percent above the optimum moisture content, as determined in accordance with ASTM D698.

8. Weather Limitations

Unless approved in the field by the geotechnical engineer, neither controlled embankment cap fill nor slurry backfilling shall be constructed when the atmospheric temperature is at 35 degrees F. It shall be the responsibility of the contractor to protect the slurry backfill or slurry wall cap against any detrimental effects by methods approved by the geotechnical engineer. Any material damaged by freezing shall be reconditioned, reshaped and recompacted, if necessary, by the contractor in conformance with the requirements of this specification.

9. Quality Assurance

9.1 General

The geotechnical engineer shall be responsible during

construction of the cutoff wall and cap for the following:

A. Construction observation for quality assurance of specification compliance.

B. Materials testing for compliance with specifications.

C. Slurry, slurry backfill and slurry cap testing.

D. Reports.

9.2 Construction Observations

The geotechnical engineer shall act as the owner's representative, shall be the interpreter of the site construction specifications, and shall make observations and tests as considered necessary to assess and accept the quality of the work. Continuous observation and tests of construction operations shall be made by the geotechnical engineering technician under the direction of the geotechnical engineer.

9.3 Testing of Slurry & Slurry Backfill

Bentonite used in slurry shall conform to test ranges presented in A.P.I. Specification 13A. The density and viscosity of the slurry shall be determined immediately prior to placement into the trench or boring, and at periodic intervals after that from samples taken from the trench or borings at the direction of the geotechnical engineer. In general, the sampling of the slurry trench shall be done at least twice daily at 10.0 foot depth intervals. In the large diameter borings, at least three tests will be accomplished each working day.

The soil used in the slurry backfill will have grain-size analysis and Atterberg Limits determined prior to mixing with slurry in accordance with ASTM D423 and D424. Approximately one sample per 200 cubic yards shall be tested.

The slurry backfill will have its slump determined immediately prior to placement into the excavated trench or boring in accordance with ASTM C143 at the direction of the geotechnical engineer at least twice daily.

9.4 Testing of Slurry Cutoff Cap

Grain-size analysis, Atterberg Limits and moisture-density relations shall be determined for slurry cutoff cap borrow used in accordance with ASTM D422, D423, D424 and D698. The frequency of tests shall be determined by the geotechnical engineer.

In-place density and moisture content of cutoff wall cap soils shall be determined in accordance with ASTM D1556 or ASTM D2922 as directed by the geotechnical engineer.

9.5 Quality Control Reports

The geotechnical engineer shall submit reports of observations and tests to the owner.

A daily log of construction activities shall be maintained at the jobsite. The log shall report the construction activities, the day's test program, and the date, temperature, and general weather conditions. A copy of the daily log will be available for inspection by the owner and regulatory agencies.

Test reports shall be submitted to the owner weekly. A copy of all test results will be maintained at the construction site.

Test results shall include the following:

A. Date issued.

B. Project title and number.

C. Date of testing and/or sampling.

D. Type of test.

E. Location of test.

F. Observations regarding compliance or noncompliance with plans and specifications.

Upon completion of construction, the geotechnical engineer shall submit a final quality control report certifying the project is complete in accordance with plans and specifications, and presenting all tests, as-built plans, and other supporting data.

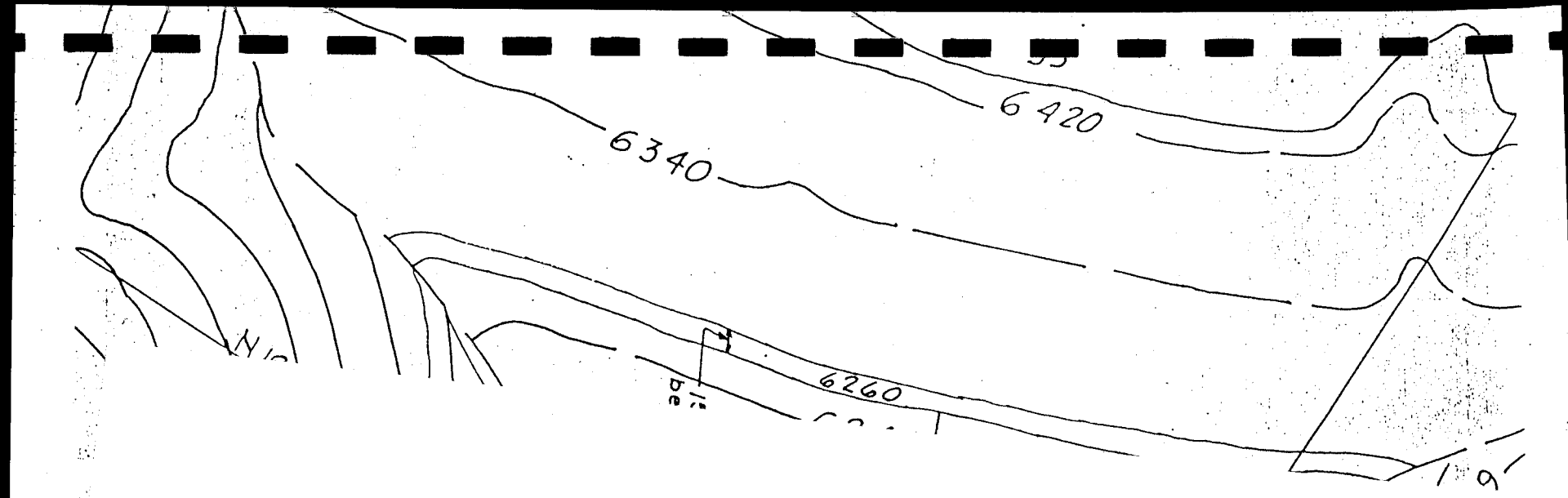
6420
6340
6260

FIGURE 2

SECTION B-B'

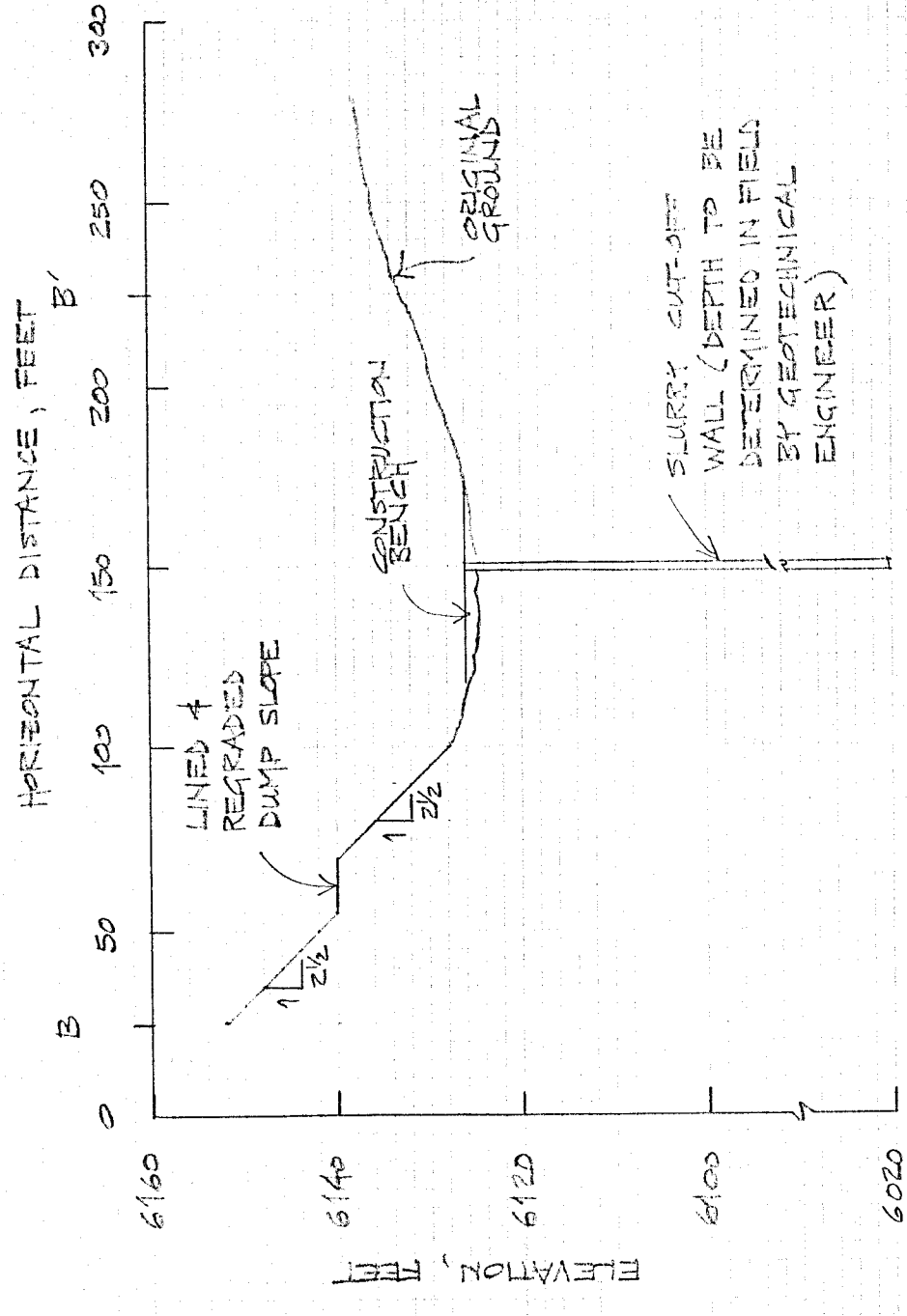

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FIGURE 3

SECTION A-A'

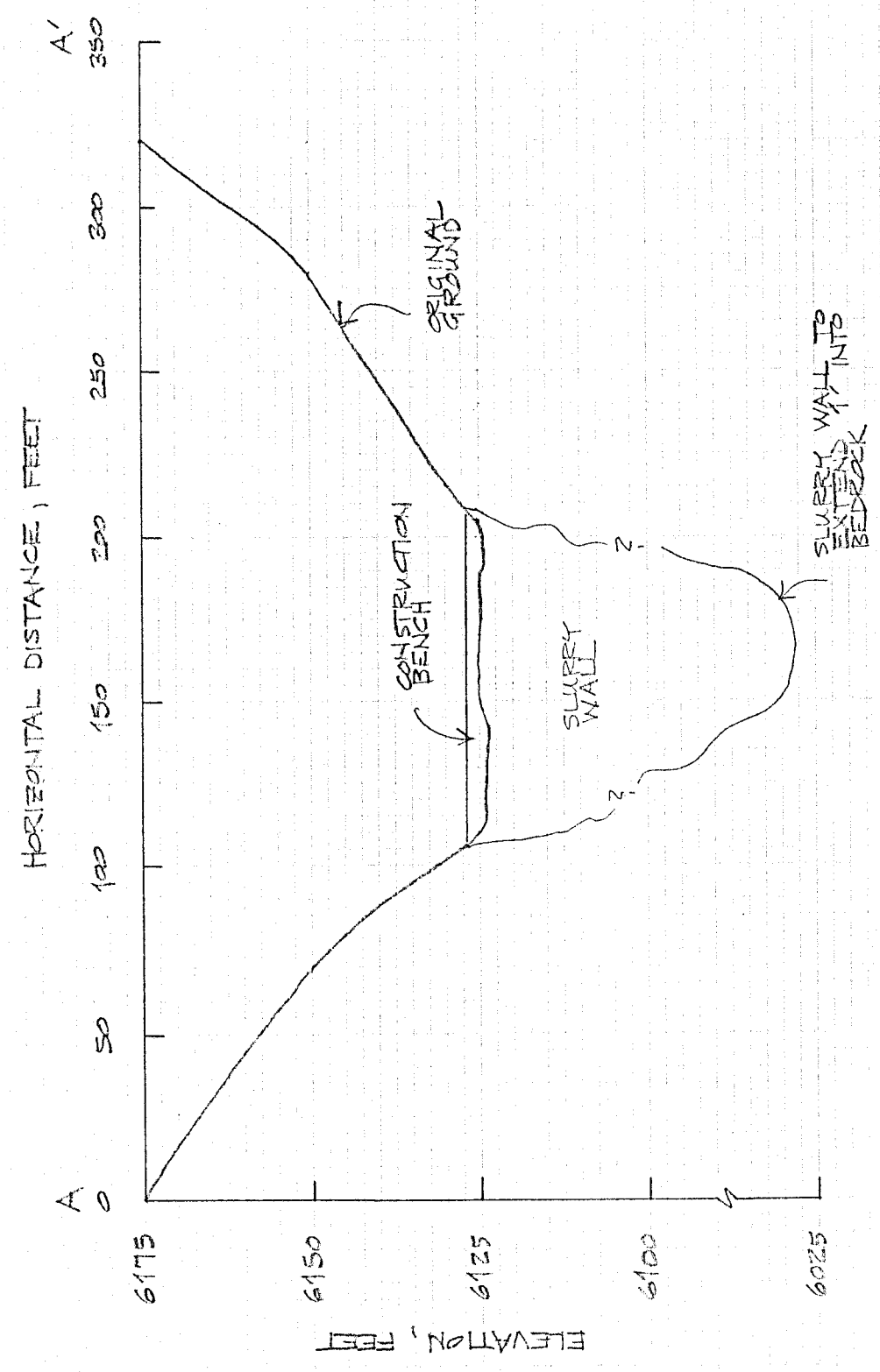

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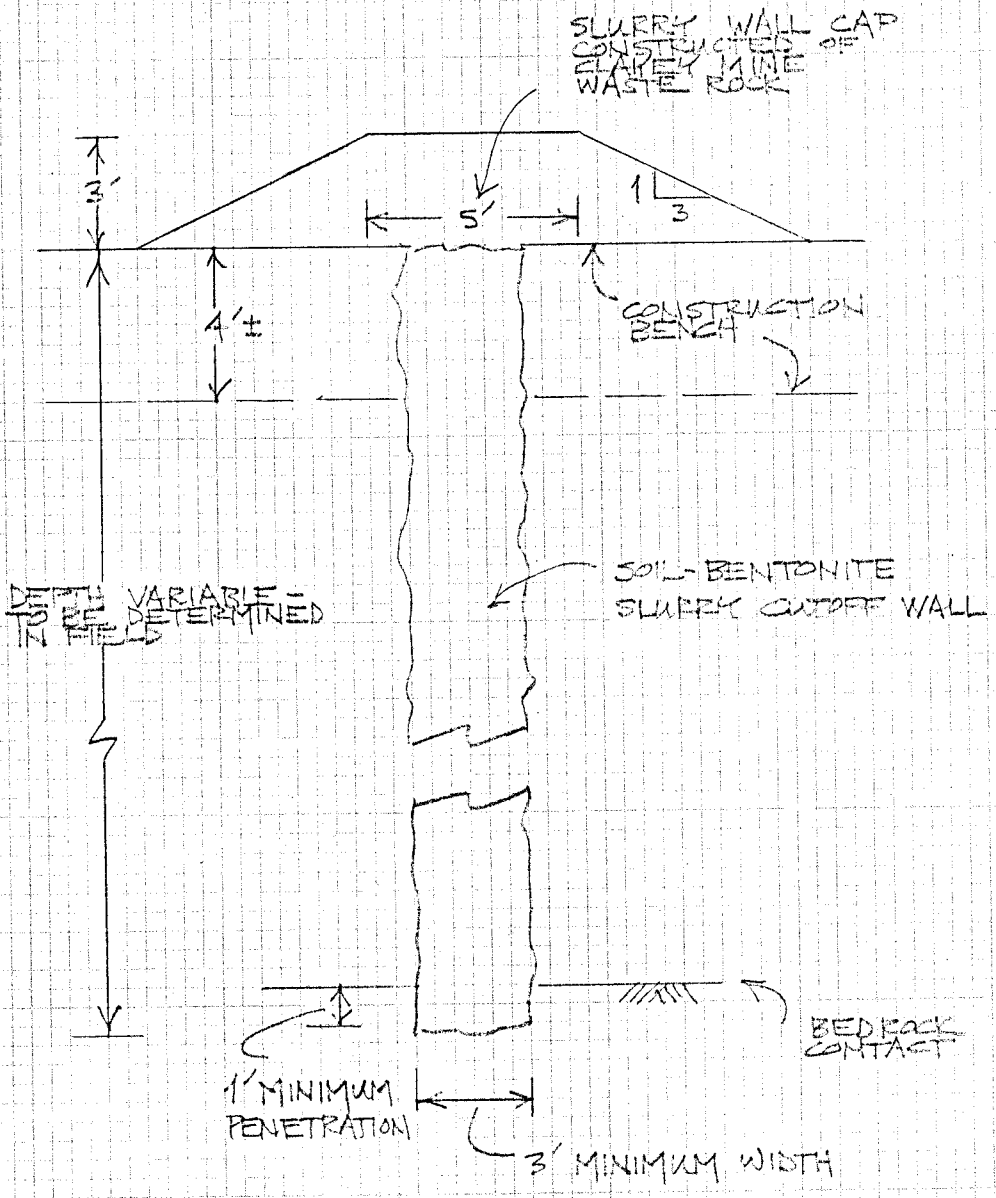
FIGURE 4

TYPICAL CROSS-SECTION
THROUGH CUTOFF WALL



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